

The University of Chicago

MENTAL SET IN RELATION
TO RETROACTIVE
INHIBITION

A PART OF THE DISSERTATION SUBMITTED TO
THE GRADUATE FACULTY IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

By
OLIVE PECKHAM LESTER

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MENTAL SET IN RELATION TO RETROACTIVE INHIBITION¹

BY OLIVE P. LESTER

The University of Buffalo

SECTION I. INTRODUCTION

The fact that the recall of any learned material is interfered with or decreased by the interpolation of certain forms of activity between the original learning and recall has been clearly demonstrated in numerous investigations. Psychologists have denoted this occurrence by the term retroactive inhibition. The investigation under consideration assumes the existence of this retroactive phenomenon and then raises the question as to the possible relation between inhibition and learning set or attitude. More specifically stated, what is the influence or effect of the following attitudes on the susceptibility of learned material to retroactive inhibition?

1. The expectation of recall.
2. The expectation of interpolated material before recall.
3. Information as to the possible effects of interpolated material.
4. The assumption of an active attempt to avoid the detrimental influence of the interpolated material.

Space does not permit an historical review of the experimental literature on retroaction, and attitudes at the time of learning. To the writer's knowledge, no work on the relation of mental set to retroactive inhibition has been reported, though much experimental data on set in relation to learning, and recall is at hand.

SECTION II. PROCEDURE

A. MATERIAL

The memory material employed throughout the investigation, both for the original and for the interpolated learning, consisted exclusively of standard lists of twelve three-letter nonsense syllables.

¹ From the Psychological Laboratory of The University of Chicago. The writer wishes to express her appreciation to Professor A. G. Bills for the helpful advice and assistance given by him throughout this experimentation.

B. APPARATUS

An electrically driven memory drum, of the type devised by Clark Hull, constituted the apparatus. The lists of nonsense material were placed on the drum, and the timing device set so as to allow a constant exposure of three seconds for each nonsense syllable. Thus, a complete presentation of the twelve syllables necessitated thirty-six seconds. The drum continued to rotate until each subject was able to give one perfect recitation of the list, *i.e.* to anticipate by spelling aloud, in each case, the syllable following the one then being presented to him on the drum. The list of nonsense material was then considered learned. The automatic control of the presentation time left the experimenter free to record the learning data of the subjects.

C. SUBJECTS

The subjects were undergraduate students at the University of Buffalo during the college year 1929-30. The data in the main were obtained from freshman men and women, although the results on a number of second year students were also included. In those instances in which sophomores were used as subjects, only those who were not carrying the regular elementary course in psychology were included; or, if such students were employed, the experimenter made certain, in each case, that class discussions had not, up to that time, involved any material on retroactive inhibition, set at time of learning, and the like. This precaution insured that very little, if any, knowledge existed on the part of the subjects concerning the problem under investigation.

D. METHODS

The experiment was performed to answer the question whether directions at the time of learning (set) would have any effect upon the susceptibility of learned material to retroactive inhibition. Such a problem called for the usual learning and retention set-up, *i.e.* the learning of the original material; a time interval between original learning and recall, during which the interpolated material was introduced; the subsequent recall of the originally learned material.

In this experiment, the time interval between learning and recall was twenty-four hours; the interpolated learning material was introduced immediately prior to recall. The retention of the original material was measured by the anticipation and relearning methods, *i.e.* the number of nonsense syllables correctly anticipated during the first trial of the relearning constituted one measure of retention, and the total number of trials necessary to relearn the list to the point of one perfect anticipation of each of the twelve succeeding nonsense syllables was taken as the second measure of retention.

Simple, uniform directions for the recall technique were given to all subjects just prior to recall.

The original learning, the time interval, the interpolated learning, and the recall procedure remained the same throughout the experiment. Different directions read by the subject at the time of learning introduced the factor of varying set or attitude—the one variable in our experimental investigation. These different directions, as presented to the subjects, determined the specific conditions of the experiment which were as follows:

*Condition I*Learn O²No I³

Recall

No expected recall

² Abbreviation for original learning.³ Abbreviation for interpolated learning.

<i>Condition II</i>		
Learn O	No I	Recall
Expected recall		
<i>Condition III</i>		
Learn O	I introduced	Recall
No expected recall		
No expected interpolated task		
<i>Condition IV</i>		
Learn O	I introduced	Recall
Expected recall		
No expected interpolated task		
<i>Condition V</i>		
Learn O	I introduced	Recall
Expected recall		
Expected interpolated task		
<i>Condition VI</i>		
Learn O	I introduced	Recall
Expected recall		
Expected interpolated task; S. told something of its possible effects		
<i>Condition VII</i>		
Learn O	I introduced	Recall
Expected recall		
Expected interpolated task; S. told something of possible effects, and urged to resist effects		

The printed directions, read by the subjects at the time of learning, with reference to the expectation of recall and interpolated learning, were as follows:

Condition I

No printed directions were given at the time of learning the original material, but the subject was instructed to return the following day for the purpose of learning another list. This second learning was actually carried out, but only after the recall of the original list.

Condition II

"You are going to be required to recall, tomorrow at this time, the list of nonsense syllables you are now learning. Do not practice on the list after leaving here."

Condition III

No printed directions were given at the time of learning the original list, but the subject was instructed to return the following day in order to learn another list. The learning of this list on the succeeding day, since it constituted, in reality, the interpolated task, was actually carried out, after which the recall of the original material took place.

Condition IV

"You are going to be required to recall, tomorrow at this time, the list of nonsense syllables you are now learning. Do not practice on the list after leaving here."
These directions were identical with those of Condition II.

Condition V

"You are going to be required to recall, tomorrow at this time, the list of nonsense syllables you are now learning, but, before recalling this list tomorrow, you will learn another list of nonsense syllables similar to the list you are learning today. Do not practice on the list you learn today after leaving here."

Condition VI

"You are going to be required to recall, tomorrow at this time, the list of nonsense syllables you are now learning, but, before recalling this list tomorrow, you will learn another list of nonsense syllables similar to the list you are learning today. The effect of learning a second list is usually detrimental to the remembering of the first list—that is, it is likely to cause confusion. You tend to mix up syllables learned in the second list with those in the first list. Do not practice on the list you learn today after leaving here."

Condition VII

"You are going to be required to recall, tomorrow at this time, the list of nonsense syllables you are now learning, but, before recalling this list tomorrow, you will learn another list of nonsense syllables similar to the list you are learning today. The effect of learning a second list is usually detrimental to the remembering of the first list—that is, it is likely to cause confusion. To avoid mixing up the syllables of the second list with those of the first list, take special care to keep them separate. Learn the first list in such a way that you will not confuse it with the second list. Do not practice on the list you learn today after leaving here."

In order to reduce to a minimum the variability necessarily accompanying oral directions given by an experimenter, each subject was requested to read the directions, and then to state his understanding of them. In the event that the subject omitted an important point, he was referred once more to the instructions in question.

It will be noted that each condition of the experiment, with the exceptions of I, II, and III, presented more and more information relative to the nature of the experimental set-up—the expectation of recall, the expectation of the interpolated list, further knowledge concerning the possible effects of the interpolated list, and, finally, the suggestion to learn the material in such a way as to eliminate or at least to mitigate the effects of the interpolated list on the recall of the original list.

Condition III should furnish data showing what may be called 'raw' retroactive effects. Particularly is this true if the results of this condition are compared with those of Condition I where no interpolated learning was introduced into the experimental procedure. Then, comparing the findings under Condition III with those under Conditions IV, V, VI, and VII, we may possibly draw certain conclusions concerning the effect of attitude or set at time of learning on the disruptive effects called retroaction.

Of the two hundred subjects participating in this experiment, twenty-one served under both Conditions I and II; twenty under Condition III; thirty-three under Condition IV; thirty-four under Condition V; thirty-five under both Conditions VI and VII. All of these subjects came to the experimenter on four successive days.⁴ On each of the first two experimental days, the subjects learned a list of nonsense syllables similar to the list of so-called original material to be learned on the third experimental day.

⁴ In some instances, one day intervened between the first and second experimental days, or between the second and third experimental days; but at no time did more than twenty-four hours elapse between the third and fourth experimental days.

One of the objects of these two practice sittings was to familiarize the subjects with the experimental apparatus and procedure; the other, to provide the experimenter with some basis for equating the different groups of individuals. On the third experimental day, the subjects learned the nonsense material under the experimental conditions specified, and on the fourth experimental day, the recall was measured.

An average of the number of trials necessary in order to learn the first two lists was computed for every subject. Using such averages for the first sixty-eight persons participating in the experiment, the median, upper, and lower quartile points were computed. They were found to be as follows:

	Trials to learn
Median (Q_2).....	30.75
Q_3	38.00
Q_1	25.25

The range of the average trials to learn was from 12-59.

Approximately the same number of poor, average, and good learners⁵ were assigned to each group so that, under the several conditions, the groups are comparable as to the average number of trials necessary to learn the first two lists of nonsense syllables.

It may be argued that two practice trials do not afford sufficient basis for a classification of individuals as poor, average, and rapid learners. Possibly this argument is entirely valid, yet it seemed advisable to make some effort to equate the groups in as many respects as possible, *i.e.* age, sex, college year, and, lastly, learning ability.⁶ Perhaps the only achievement was a rough classification within the groups of those individuals whom Meumann designated as 'die schnellen und die langsamen Lerner.'

⁵ The poor learners were classified arbitrarily as those who learned in more than 38.00 trials; the average learned in from 25.26 to 38.00 trials; and the good learners were those who succeeded in 25.25 trials or less.

⁶ It was suggested that the groups be equated as to intelligence or possibly high school record. The correlation between intelligence, as measured by the American Council on Education Test, and the average number of trials to learn a list of nonsense syllables was $r = +.18$; between high school rank and average number of trials, $r = -.03$. The first correlation above was computed on the basis of 185 cases; the second, on 203 cases. The decided lowness of these correlations influenced the writer against employing high school records or intelligence test scores in equating the groups. A larger number of practice trials in learning lists of syllables might have raised these correlations, but this seems questionable.

All of the learning throughout the experiment was done in the same room—a large quiet office—with only the experimenter present. No subject was asked to participate in the experimental work prior to 12 o'clock. In so far as possible, a subject worked at the same hour on the various experimental days.

The question of experimental controls also enters. When sets of directions are being given and their effects studied, and particularly when these directions are so arranged as to give more and more information concerning the experiment, it becomes of considerable importance that a subject, supposedly working under one set of directions or conditions, is not influenced by directions previously given to other subjects. In the present experiment, such a difficulty was obviated by completing each experimental condition, as far as the number of subjects was concerned, before proceeding to the subsequent condition.⁷

A phase of the experiment which may be open to criticism is the lack of control of the subjects by the experimenter dur-

⁷ When it seemed advisable, in order to test the significance of various differences, to add to the number of cases under Conditions IV, V, VI, and VII, the rather troublesome situation arose of using subjects under Conditions IV and V, for example, whose acquaintances had, possibly, already worked under Conditions VI and VII. This difficulty was met in the following manner: Additional subjects under Conditions IV and VI were informed that the experimenter was working on an entirely different phase of the problem, one under which students had not previously served as subjects. Needless to say, subjects were added to Condition IV before additions were made to Condition VI. Condition V was held over until the Summer Session of 1930. At this time subjects of the same relative ages, and apparently unfamiliar with the experimental problem, from the elementary psychology course were employed. Condition VII, because it gave the most complete information, was not affected. The constancy of the average number of trials necessary to relearn the material and the number of syllables recalled during the first trial led to the conclusion that the additional subjects in Condition VI were unaffected by any other directions. The shift of means in the two measures of recall in Conditions IV and V, when added subjects had been employed, led the experimenter to run twenty-seven entering freshmen of the 1930-31 school year under these conditions—thirteen of these under Condition IV and fourteen under Condition V. The mean trials of these additional subjects to relearn and anticipate syllables resembled more the original twenty cases under each condition. This would seem to indicate that those cases in Conditions IV and V, added during the Spring and Summer Session of 1930, had been influenced by directions other than those given by the experimenter. For this reason, Conditions IV and V, as discussed here and in the following section, are each composed of the original twenty cases plus the added cases drawn from the entering freshman group of the college year 1930-31.

ing the twenty-four hours which elapsed between the learning of the original material and the recall. Although all subjects were directed not to practice on the lists after leaving the experimenter, there was no guarantee of their compliance with the request. In this regard, the present investigation suffers no more than any experiment in which absolute control of the subjects during the time interval between learning and recall is impossible or impracticable. Whenever directions stating that a recall will take place are given, any experimenter necessarily throws himself upon the weakness, or perhaps the strength, of his human material, and his findings must always be evaluated with that uncontrolled factor in mind. Of course an experimenter may attempt to insure accuracy by asking his subjects whether or not they have practiced on the lists of learned material, or he may utilize the more objective criterion of a recall performance which, by its obvious perfection, indicates additional practice. Such results would necessarily be discarded. However, it seems, in the main, practically necessary to rely on the integrity of the subjects themselves.

SECTION III. RESULTS

Conditions I and II were introduced into the experiment merely as controls with the view, first, of ascertaining the effect of knowledge, or lack of knowledge, of recall on the retention of a previously learned list of nonsense syllables and, secondly, for the purpose of comparing retention in the presence and absence of interpolation of similar learning material. Table I, given below, presents the retention in terms of number of trials to relearn and the number of syllables recalled the first trial for the first three conditions of the experiment:

TABLE I
AVERAGE TRIALS TO RELEARN, AND AVERAGE NUMBER SYLLABLES RECALLED
FIRST TRIAL IN CONDITIONS I, II AND III

Cond.	No. of Cases	Ave. No. Trials to Relearn List	P.E.	Ave. No. Syllables Recalled 1st Trial	P.E.
I	21	8.14	.540	4.24	.322
II	21	6.05	.421	4.57	.340
III	20	11.35	.525	.400	.132

The retention measured in trials to relearn in Condition II is significantly greater than the retention under Condition I, being 3.05 times the P.E. of the difference. At the same time, no significant difference exists between the conditions in the number of syllables recalled on the first trial. If one assumes that directions at time of learning,—in this case, knowledge of a subsequent recall,—establish a set or *Einstellung* that facilitates or energizes the learning process, such facilitation is not apparent in the amount actually recalled under Condition II. However, if one distinguishes as did Ebbinghaus between conscious retention and unconscious retention, then in Condition II there is evidence of greater unconscious retention. If the learning process and retention are thought of as involving basically a modification of neural processes, then a saving in trials necessary to relearn is a good index of the amount of permanent learning or acquisition. The amount of retention expressed by the savings score is 74.9 percent in Condition II and 66.6 percent in Condition I.

Contrasting Condition III with Conditions I and II, the disturbing effects of an interpolated list on the retention of previously learned material may easily be observed. As was to be expected, the differences in retention between Conditions II and III are greater than between Conditions I and III.

Although the present experimental procedure was not arranged to test the effect of the temporal position of the interpolated learning on the amount of retroactive inhibition, nevertheless, it incidentally brings out clearly the retroactive effects of such interpolated learning when it is introduced prior to recall. This evidence tends to refute Müller and Pilzecker's perseveration hypothesis as an explanation of retroactive inhibition.

Table 2 illustrates the retention in Condition III compared with retention in the other conditions of the experiment:

TABLE 2
AVERAGE TRIALS TO LEARN AND RELEARN, AND AVERAGE NUMBER SYLLABLES
RECALLED FIRST TRIAL UNDER CONDITIONS I-VII OF EXPERIMENT

Cond.	No. of Cases	Ave. No. Trials to Learn List	Ave. No. Trials to Relearn List	P.E.	Savings Score	Ave. No. Syllables Recalled 1st Trial	P.E.	Percent of Material Recalled
I	21	24.33	8.14	.540	66.6%	4.24	.322	35.3
II	21	24.14	6.05	.421	79.4%	4.57	.340	38.1
III	20	25.30	11.35	.525	55.2%	.400	.132	3.3
IV	33	24.42	8.21	.338	66.4%	1.18	.180	9.8
V	34	24.32	8.79	.330	63.9%	1.23	.138	10.2
VI	35	22.91	7.48	.288	67.4%	1.54	.152	12.8
VII	35	23.48	6.83	.292	70.9%	3.08	.261	25.7

Condition III illustrates what has previously been referred to as the 'raw' effect of retroactive inhibition. In this condition, information, directions and mental set, in their relation to the phenomenon of retroaction, are at a minimum. This may, therefore, be considered the basic condition against which the other conditions involving retroaction are compared. The effectiveness of directions at the time of learning must be measured in terms of the greater amount of retention in those conditions where such directions are given as compared with the amount of retention in Condition III.

Condition IV is the first one in which directions are introduced along with the presentation of the interpolated learning. In this condition, the subjects were aware at the time of learning that a recall of the original material was to occur.

The directions given under Condition V led the subjects to expect a recall of the original list and also acquainted them with the fact that another list was to be learned prior to the recall.

The next set of directions—those employed under Condition VI—informed the subjects at the time of learning the original lists that a recall would take place, and that another list of similar syllables would be learned prior to recall. The possible interference effect of this list on the retention of the original learning was also stated.

In Condition VII, the subjects were provided with all of the information given in Condition VI, and the following statement was added: "To avoid mixing up the syllables of the

second list with those of the first list, take special care to keep them separate. Learn the first list in such a way that you will not confuse it with the second list."

A glance at the preceding table brings one to the obvious conclusion that set or attitude at time of learning, whether it be knowledge of recall, knowledge of the presentation of the interpolated material, knowledge of its possible effects, or an attempt to avoid the detrimental influence of the interpolation, has a significant effect on the amount of retention. This increase in the amount of retention holds true under both methods of measurement employed in this experiment.

A comparison of Conditions I and III, and II and IV respectively, shows definitely that retroaction is greater when measured in terms of recall than when tested by relearning. When interpolated learning is introduced, there is an average decrease in recall of 30.2 percent. If the retention measure is in terms of relearning, there is an average decline of 12.2 percent.

Having established experimentally that mental sets brought about by means of directions given at the time of learning do augment retention or, contrariwise, retard or reduce retroaction, we encounter the further question: Do the directions act differentially on the amount of retention? Does a knowledge of recall and expectation of an interpolated list increase retention more than a mere knowledge of recall? Further, does knowledge of the possible effects of an interpolated list increase retention more than just the bare expectation of such a list? And, lastly, will the directions, indicating that subjects should learn the original list in such a way as to prevent the interference effects of the interpolated list, be still more effective in increasing recall?

If, in arriving at conclusions, consideration is restricted to those differences between the means that are significant, the data seem to indicate little difference in retention between Conditions IV, V, and VI. Apparently, if subjects are not told to avoid the retroactive effect, *i.e.* to avoid interference resulting from the interpolated list, it is of little avail to notify them that there is to be such a list or to inform them of its

effect. In fact, mere anticipation of the presentation of a second list of similar material to be learned, or mere knowledge of the possible results therefrom seems no more effective in overcoming retroactive effects than knowledge of a recall of the original learning.

This conclusion applies to retention as measured by both criteria. Table 3, which follows, presents these differences between means in Conditions IV, V, and VI, the P.E. of the differences, and the number of times the differences exceed the P.E.

TABLE 3
DIFFERENCE BETWEEN MEANS, P.E. OF DIFFERENCE, AND TIMES DIFFERENCE
EXCEEDS P.E. IN CONDITIONS IV, V, AND VI

Cond.	Difference Between Means		P.E. of Difference		Times Difference Exceeds P.E.	
	Trials to Relearn	Syllables Recalled First Trial	Trials to Relearn	Syllables Recalled First Trial	Trials to Relearn	Syllables Recalled First Trial
IV-V	.58(IV)	.05(V)	.473	.227	1.23	.02
IV-VI	.73(VI)	.36(VI)	.444	.236	1.65	1.53
V-VI	1.31(VI)	.31(VI)	.438	.205	2.99	1.51

Note: Numerals in parenthesis indicate condition favored.

However, if one follows the trends in the data presented by Table 3, it would appear that the results under Condition VI are consistently better than those under Condition IV or V. This result holds in both of the measures of retention. Further illustration of this tendency is apparent in the data given in Table 2. Comparing savings scores, Condition VI shows a retention of 67.4 percent as compared with 66.4 percent and 63.9 percent under Conditions IV and V respectively. If measured by the percent of material recalled, retention shows a progressive increase in amount as one proceeds from Condition IV to Condition VI. Thus, there appears to be a tendency for retention to be a function of the inclusiveness of directions.

Condition VI presented the opportunity for more motivation in the original learning, though this motivation was not established directly by instructions. When subjects are made

aware of the possible effects of a second learning situation, as in Condition VI, for some, if not all, of them there must be a self-induced set to counter-act, if possible, the disturbing effect.

The absence of any very significant differences between Conditions V and VI may be explained in part, at least, by assuming that the conditions were basically similar for some of the subjects under both conditions. Some subjects under Condition V, when told of the subsequent presentation of an interpolated list, inferred its effect. This was evidenced by expression of "Oh, that will mix me up!" Further evidence of the same reaction was obtained by asking a number of subjects, after they had completed the experiment, what ideas as to the effect of learning a similar list of syllables occurred to them upon reading the printed directions. They unhesitatingly replied, "Oh, I thought it would interfere."

The possibility also arises that those subjects in Condition V, who were not far-sighted or imaginative enough to foresee the possible consequences of the directions, benefited no more from knowledge of a recall and interpolated list, than did those subjects who knew only of a recall. This suggestion may account for the absence of any difference in retention between this Condition and Condition IV.

Any experimenter, at this point, finds himself confronted by those factors of individual differences which make the stimulus he controls, and believes to be somewhat objectively defined, a variable thing. A set of directions, stating that an interpolated list will be introduced prior to relearning, will produce in some of even a naïve group of subjects the thought, apprehension, or attitude of expected interference; in the case of other subjects, equally naïve as regards such concepts as retroactive inhibition and the like, no such outcome is envisaged. It appears to the present experimenter that such considerations may have eliminated or, at least, dimmed the supposedly clear-cut quantitative differences in directions. It is for this reason that the trends in favor of Conditions V and VI are significant. They seem to transcend the very likeness that may have come into the directions.

Turning now to a consideration of Condition VII, it will be remembered that subjects were here directed to learn in such a way that the second list would not be likely to interfere with the remembering of the first list. This attitude, induced by such directions, was presumably the most active. The following table shows Condition VII compared with Conditions IV, V, and VI.

TABLE 4
DIFFERENCE BETWEEN MEANS, P.E. OF DIFFERENCE, AND TIMES DIFFERENCE EXCEEDS P.E. IN CONDITIONS IV, V, VI AND VII

Cond.	Difference Between Means		P.E. of Difference		Times Difference Exceeds P.E.	
	Trials to Relearn	Syllables Recalled First Trial	Trials to Relearn	Syllables Recalled First Trial	Trials to Relearn	Syllables Recalled First Trial
IV-VII	1.37(VII)	1.90(VII)	.447	.317	3.09	6.00
V-VII	1.96(VII)	1.85(VII)	.441	.295	4.44	6.27
VI-VII	.65(VII)	1.54(VII)	.410	.302	1.58	5.09

Note: Numerals in parenthesis indicate condition favored.

All of the above differences in retention, with the exception of the difference between Conditions VI and VII, measured by trials to relearn, are significant, and show Condition VII to be the superior one.

The effectiveness of a more active set as represented by Condition VII at the time of learning, in relation to retroactive inhibition may possibly be more vividly illustrated by a comparison with retention in Conditions I and II. Measured by the number of trials to relearn, Condition VII is superior to a condition in which no retroactive effects occur; and only slightly inferior to that in which a knowledge of recall and no retroactive effect occurs. Computing the savings score, there is a retention of 70.9 percent in Condition VII; 66.6 in Condition I; and 79.4 in Condition II. In terms of the percentage of material actually recalled, the retention is 25.7 for Condition VII; 35.3 for Condition I and 38.1 for Condition II. This latter finding also indicates that the effects of retroactive inhibition are greater on the phase of retention which is measured by the recall method.

SECTION IV. CONCLUSIONS AND DISCUSSION OF RESULTS

Conclusions

The foregoing experimental project has brought to light several findings worthy of summary and discussion.

1. Directions to the subject informing him what to anticipate at the time of learning,—*i.e.* presence of a recall; expectation of interpolated list; information in regard to the possible effects of an interpolated list—any one or all of these presented at the time of the original learning very definitely minimize the retroactive effects and increase the retention of the original material.

2. There is a consistent trend in the data pointing to increasing degrees of retention with increasing amounts of information given at the time of learning, although the differences, taken individually, do not prove to be statistically significant.

3. Directions urging the subject to make an effort to avoid the interference effects of the interpolated list result in a significantly greater retention than is obtained under any of the other conditions involving informatory directions.

4. The presence of considerable retroactive inhibition has been shown to exist when the interpolated learning of similar nonsense material is introduced immediately prior to a recall of the originally learned nonsense material and twenty-four hours after the original learning.

Such a finding, while in no sense new, would seem to further substantiate Robinson's (5) conclusion that retroactive inhibition is not due to the disturbance of a perseverative process immediately after learning, but is a function rather of some other factor, such as associative interference, due to the similarity between the interpolated activity and the original learning.

It might be interesting to duplicate this same experiment in all respects except to introduce the interpolated learning immediately after the original learning. This would decide the question as to whether interference with any hypothetical perseverative tendencies would in any way change the results here obtained.

5. Retroactive effects are definitely more detrimental to

retention as measured by the recall method, than to retention measured by the relearning method.

The findings of the present investigator corroborate in this respect the results of McGeoch (3), and are somewhat similar to the early experimental conclusions of Heine (2). However, the latter worked with recognition and recall as measures of retention, and hence it is only by considering recognition and relearning as being somewhat alike as measures of retention, in contrast to recall as a measure, that we can compare the two results.

Discussion

The main outcome of the experiment is, therefore, its demonstration that directions establishing a set or attitude at the time of learning have the effect of minimizing or curtailing retroactive inhibition. Some explanation of this decrease in so well recognized a phenomenon is necessary.

The word 'set' may be variously defined. For instance, it may denote a bodily posture temporarily assumed by an organism, *i.e.* the runner toeing the line, or the cat crouching for a mouse. Here is an illustration of a preparation for action which involves observable changes in the adjustment of muscles. But set may also be defined as that mental attitude which is the result of specific work instructions, and which may or may not involve changes in muscular tonus, or the assumption of any particular bodily attitude, on the subject's part. It is this latter definition or meaning of set with which we are dealing in this study. It seems probable that the directions, acting as a stimulus, established an integrated neural pattern which energized or facilitated the learning process that was being carried on.

As Bills (1) pointed out, the dynamogenic influence of simultaneous processes on one another has long been recognized, although the analysis of these processes and of the phenomenon of facilitation has not been investigated very adequately, either on the subjective or on the neurophysiological side. A theoretical explanation is offered in the drainage hypothesis of McDougall which, in rather vague terms, attempts to account for facilitation by assuming that an on-

going activity, such as learning, drafts the neural energy from impulses simultaneously aroused in adjacent neural systems. When we talk in terms of set we have not advanced very far from the *Einstellung* of Watt and the determining tendency of Ach and Woodworth.

Inherent or implicit in the concept of determining tendency is the implication that the tendency operates superiorly to reinforce certain reactions, *i.e.* a determining tendency to add

or subtract or multiply in the case of $\frac{5}{2}$ strengthens one association—7, 3, or 10 respectively—and the implications are that such a set would operate in the formation of such associations. Peterson (4), in a study on the effect on learning of attitudes produced by the knowledge or lack of knowledge that recall would be required, obtained differential results for the two attitudes. He refers to the ‘will to learn’ attitude, as discussed by Ebert and Meumann, and the fact that this attitude exerts an effect on the efficiency of memory. He states, furthermore, that particular adjustments of this attitude are manifested, *i.e.* if the subject endeavored to recall meanings rather than words, a better reproduction of meanings occurred and vice versa. In reference to his own experimental data, Peterson contends that the additional stimulus which produced the will to learn was the statement to students, before giving the list, that they would be asked to reproduce the words contained therein. This knowledge, Peterson thinks, produced, through various neural dispositions, a far more definite response attitude than was possible when no directions were given. It may be that our directions operated in a similar fashion.

Mention has already been made, in the section devoted to the results of this experiment, of the greater retention, measured by the savings method, in Condition II than in Condition I. Condition II gave knowledge of a recall. Here the attitude at the time of learning apparently facilitated the learning—in the sense of bringing about a more complete acquisition. It will be noted that the average number of trials to learn was approximately the same, in each case.

In order that more definite proof might be obtained of the

energizing effect of directions on learning and on subsequent retention, eleven subjects were given directions similar to those under Condition VII and on the fourth experimental day were asked only for a recall. The condition thus obtained involved a more active learning attitude than any other condition in the entire experimental procedure, with the exception of Condition VII. The average number of trials necessary to learn the original list was 23.54; the number of trials to relearn, 4.30. Expressed in terms of savings score there is a retention of 81.5 percent. This amount of retention is rendered more conspicuous when compared with the retention of 66.6 percent and 74.9 percent under Conditions I and II.

There is also some indication of the facilitating effect of directions, apparent in the average number of trials required to learn the original lists under the several conditions of the experiment. Assuming, as seems justifiable, that our groups were approximately equal in respect to the capacity or ability for learning meaningless material, the tendency for the average trials to learn, to decrease as the directions become more complete would seem to indicate the greater effectiveness of such directions in energizing the learning. Reference to Table 2 in the section on results will make more clear the above inference.

If we assume that the interpolation of similar learning material introduces a disruptive force affecting the retention of the original learning, the natural expectation would be that the more efficiently learned material would be more easily retained under interference conditions. It would also be anticipated that the subjects possessing some expectation of the requirement of a recall, and of the introduction of interpolated material, would be less influenced by the actual presentation of the latter. In other words, preparation for a future contingency greatly lessens the startling or upsetting effect of its actuality.

Reference to Table 2 will illustrate that retroactive effects are more apparent when the number of syllables recalled is taken as a measure of retention. The differences between the several conditions of the experiment are also greater when

this criterion is employed. This is to be explained largely in terms of the interference which occurs when a recall is demanded after the learning of the interpolated material. Considerable confusion is evident in the lists as recalled at this time. For instance, the transfer causing retroaction may be, in one case, a shift from original memorizing to interpolation; and, in another, a transfer from interpolated to original material. Such interference would make itself apparent during the subject's immediate recall more than in his trials to relearn since the exposure of the original list and the subsequent presentations allow an opportunity for the interference effects to wear off.

In our discussion of the active attitude or set, we have assumed that it acted directly upon the learning process to energize it. But there is an alternative possibility that the effect of set or attitude on retention could be explained on the basis of a theory of perseveration. Although the present experimental procedure, since it entails a lapse of twenty-four hours before the recall, does not preclude this hypothesis, the writer feels such a theory to be highly improbable.⁸ It might be suggested that subjects under the directions of a recall, with knowledge of an impending interpolated list, or with an active set to overcome the interference effect of such a list, were put in a condition (mild anxiety, certain amount of tension, desire for a good performance) that favored the perseverating, and 'setting in' of these lists of nonsense syllables. That is, the directions created a background of mental events which might have augmented the perseverative tendencies. Such a conclusion is not entirely inconsistent with material already at hand concerning a tendency to greater perseveration under conditions of anxiety, worry or remorse. Watt's theory (7) of reluctance fits into this interpretation also.

Although the field of neural organization is still relatively uninvestigated, explanations eventually should be forthcoming; and the present experiment may be considered as a small offering along the line of descriptive evidence on the effect of mental set in relation to retroaction.

⁸ It is hoped that future experiments will obtain definite and conclusive data on this point.

The words of Watt are still a challenge:

"If we wish individuals to respond to a series of single words in a specified way and they can do this, and firmly resolve to do it, we shall find that no number of repetitions will make strong enough the associations between the words of the series and other words, so as to bring the wrong words out against the intention of such individuals."

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